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AUTHOR Cuevas, Gilbert J.
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ABSTRACT

For students without a command of English, the use of English to teach mathematics skills and concepts is a barrier to learning. While research on the subject is not conclusive, it is an appropriate assumption that for a student to master the concepts, he must master the language of the concepts. Based on this premise, the Second Language Approach to Mathematics Skills (SLAMS) was designed to provide teachers with strategies for dealing with limited-English-proficient (LEP) students in the mathematics classroom. The model follows a diagnostic-prescriptive approach and has two strands, one focusing on teaching mathematics content and one emphasizing classroom development of related language skills. The activities developed for each strand are derived from specific instructional objectives of the curriculum. The teacher training model contains three components: incentive (intrinsic and extrinsic rewards), specific procedures, and content in culture, mathematics, and linguistics. A SLAMS program has been implemented at the University of Miami, and although research results are not yet available, it has been found that (1) some secondary teachers feel insecure addressing language concerns in the mathematics classroom, (2) teachers become more sensitive to the use of language in their teaching, and (3) teachers find language to be only one of a number of considerations in teaching LEP students, including student academic background, culture, and learning style. (MSE)

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Mathematics Education in a Second Language: An Instructional and Teacher Education Model

Gilbert J. Cuevas

Mathematical ideas are communicated in the classroom through a variety of means: graphically through manipulative materials, through formal and informal student-teacher and student-student interactions, and through text materials. The effectiveness of the ways in which these ideas are exchanged and communicated is an area in mathematics education that needs examination and research. The need to address this concern becomes critical when teaching students for whom English is a second language. Mathematics teachers at all grade levels report that students with limited English proficiency (LEP) encounter difficulties in understanding basic concepts and solving word problems. The language used to teach skills and concepts presents an obstacle in the learning process for those students who do not have a command of English (Austin and Howson 1979; Coffland and Cuevas 1979; Cuevas and Llabre 1981; Dawe 1983).

In recent years a number of conferences and professional meetings have addressed this issue.[1] The participants of these conferences have called for a systematic plan of research to investigate the role language plays in the learning of mathematics. In addition, the conferences have stressed the need to identify language problems that students have in mathematics, as well as instructional approaches that may help the learner overcome these problems.

It is the purpose of this paper to address each of the following questions in the context of the experiences the author and his colleagues have had as a result of a U.S. government-funded project that has been in operation for the past three years.[2]

- Can instructional strategies be developed to address the language problems minority language students may experience in mathematics? Can such strategies be developed given the knowledge we have regarding the role language plays in the learning of mathematics?

- If such instructional strategies can be developed, what are the skills that teachers will need to implement language-related activities in the mathematics classroom? How can teachers be motivated to participate in this training?

An Instructional Model

The overall picture that emerges from research studies concerning minority language students and mathematics achievement is neither clear nor conclusive. One strategy in designing instructional approaches for teaching mathematics in a second language is to address those variables that have been identified as playing a role in the learning of mathematics by LEP students.[3]

The relationship between language factors and mathematics achievement is not clearly understood, but it may be appropriate to assume that in order for a student to master the mathematics concepts, the language of the concepts must be mastered. Based on this premise, the Second Language Approach to Mathematics Skills (SLAMS) was designed to provide teachers with strategies for dealing with LEP students in the mathematics classroom (Cuevas 1981, 1984; Cuevas and Beech 1983). SLAMS follows a diagnostic-prescriptive approach to teaching mathematics, incorporating strategies for dealing with language skills to assist LEP students in mastering mathematics content. The model is composed of two strands, one focusing on mathematics content, the other emphasizing related language skills. The activities developed for each strand are based on identified instructional objectives from the curriculum the teacher utilizes in the classroom.

A Teacher Training Model

Basic premises and assumptions. There are a number of questions that address those factors to be considered in the development of a training process or model that provides teachers with the skills necessary to implement SLAMS in their classrooms:

1. How can teachers be sensitized to address the language needs of limited-English-proficient students in the mathematics classroom? What type of teacher incentive system should be incorporated into the training process?
2. What should be the content of the training, given the instructional model designed?
3. How should the training be conducted in order to best allow teachers to acquire the skills necessary for implementing the language approach to mathematics teaching?

Components of the training model. Based on the above three questions, the training model has three components: (1) an incentive component; (2) a procedural component; and (3) a content component.

- *Incentive component.* First, the teachers must be sensitive to the difficulties second language students experience in the classroom. Teachers must be aware that problems do exist for limited-English-proficient students in mathematics. There is the notion that since mathematics is a universal language, students, regardless of their proficiency in English, can master the concepts and skills with little trouble.[4] Second, there must be a reward system for teachers to become involved in the training process. Some of these extrinsic rewards may include college credit, stipends, or opportunities for materials development and classroom demonstration through release time from classroom instruction.

- *Procedural component.* This component deals with the actual procedures to be used for carrying out the training. These include:
  (1) Training activities which are varied and directed to the content of the training and the needs of the participants, including lectures, discussions, role playing, modeling, as well as problem-centered activities;
  (2) Provision for participants to have opportunities to generate ideas, activities, and materials as part of the training;
  (3) Provision of opportunities for demonstration, modeling, supervised observation, and feedback.

- *Content component.* In order to define the scope of the training based on the SLAMS model, the following areas of content need to be surveyed. The teachers':
  (1) Knowledge of the background and culture of the students, including any characteristics of the mathematics curriculum in the home language/country of the students;
  (2) Skills in teaching language in the context of mathematics, which includes a knowledge of the principles and techniques for teaching English as a second language;[5]
  (3) Knowledge of mathematics and methods for teaching mathematics at his or her grade level and content area;
  (4) Understanding of the linguistic demands presented by different classroom activities; it is assumed that group instruction, group tasks, and individualized learning require different linguistic skills from the teacher and the students (Christiansen and Wilson 1974).

Implementation of the Instructional and Teacher Training Models

A grant from the U.S. Department of Education allowed the University of Miami, Florida, in collaboration with a private research/consulting firm to implement the instructional and training models presented in this paper. The basic orientation of the project was to provide teachers with specific instructional and materials development strategies that incorporate a language teaching component within the mathematics lesson. Emphasis was made on the adaptation of existing teacher and commercial materials.

Approximately 250 teachers were trained through this project. Most of them were involved in the adaptation, development, and pilot testing of materials and teaching strategies that address the linguistic and cultural background of LEP students as well as the English language needs these students have in mathematics. Results of a research study conducted to examine the effects of teacher training on student achievement in mathematics are still in a preliminary stage at the time of this writing and are not yet available. I would like to offer instead some remarks concerning a sampling of the most salient experiences the teachers and project staff had during the implementation of the instructional and teacher training models.

- Some secondary teachers felt insecure in addressing language teaching concerns in the mathematics classroom; the project assisted them in developing some language teaching skills as a component of mathematics instruction.

- Most teachers who were trained to incorporate a language component into a mathematics lesson reported they were more aware of the language they used to communicate mathematical ideas, concepts, and skills to students; the teachers were more sensitive to the use of language in their teaching.

- From their experience, teachers reported that the language variable is only *one* of the many factors to be considered in teaching LEP students; familiarity with the student's academic background, culture, and learning style also need to be addressed in instructional activities.

In closing, let us remember that the student who comes from a home where English is the main language will have heard many of the linguistic structures used in the mathematics classroom. One cannot make the same assumptions for the second language learner.

Notes

1. Some of the conferences that have addressed the interaction of language and mathematics are: (1) the 1974 Nairobi Conference organized by UNESCO; (2) the 1975 Accra Conference organized by the Commonwealth Association for Science and Mathematics Education; and (3) the 1983 Mathematics Equity Conferences, organized by the U.S. National Council for Teachers of Mathematics (NCTM).
2. Dr. Phillip H. Mann and Ms. Rosemarie McClung collaborated with the author in the design and implementation of the instructional and teacher training models presented in this paper.
3. Valverde (1984), Tsang (1984), Bradley (1984) have identified these variables as language/culture, previous educational experiences, curriculum materials, instructional methods, teacher quality, and cognitive style.
4. Results of interviews with school administrators and teachers show that reference is made to *computational skills* when statements such as this one are made. Most of the educators interviewed agreed that the mathematics curriculum is more than just computation and that indeed, for other areas of mathematics instruction such as word problems, language (reading) plays an important role in the mastery of skills.
5. Reports by Christiansen and Wilson (1974, 24) and Morris (1974: 28, 51–52) from the Nairobi Conference have some thoughts on the matter of language teaching strategies within the mathematics classroom.

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